Sustainable Energy Policy

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On 18th June 2012 the Rajiv Gandhi Technical University, Bhopal (RGTU) held a day-long roundtable on solar power in which there was partnership with the Tokyo Institute of Technology and a consortium of Japanese industry in which Toyo Engineering and Ricoh had a prominent role. The RGTU and the Delhi Technical University (DTU) are both working with the Tokyo Institute of Technology on alternative energy systems which would be sustainable and environment friendly. The proposal is to set up solar power generation projects in which solar power replaces conventional fuel to convert water into superheated steam which, in turn, would drive turbines to generate electricity. The project combines the new technology of tapping solar energy and the known technology of using steam to drive power turbines for power generation.

This joint Indo-Japanese project aims at initially setting up a 30 kilowatt pilot plant of what is termed as CL-CSP technology. A pilot plant each would be located in RGTU and DTU. I did a calculation of the space requirements for such a plant. There will be 65 solar collector panels which would require a minimum land area of 750 to 800 sq.ft. The plant itself is divided into three sections, the first one of which consists of solar collectors and concentrators which heat up carbon dioxide. The second section consists of a heat exchange chamber in which carbon dioxide exchanges heat to superheat water and converts it into superheated steam. Carbon dioxide, after cooling, is circulated back for reheating to the first chamber. In the third chamber the superheated steam drives a turbine, which, in turn, generates electricity. When all the chambers are taken together this 30 kilowatt plant would probably require about 2500 sq.ft of area, which is the size of a large dwelling unit. By contrast a 30 kilowatt diesel generator set would probably need less than 100 sq.ft..

The project further envisages a one megawatt plant and a twenty megawatt plant also. One wonders whether any university in India will have that much of land space to accommodate the solar collectors needed for the larger plants. The technology is a definite advancement on the existing one of using solar collectors and both concentrating solar energy and converting it to electricity and then storing it through photo voltaic cells. In terms of land, the system appears to be highly demanding of land space and, therefore, would be inefficient on account of the land factor. In Gujarat the government seems to have a hit upon the novel idea of using the space above the Narmada main canals for setting up solar collectors because this space does not have an alternative use and the Gujarat proposal would give it the dual use of being a waterway and providing space for solar collectors. At present this is aimed at setting up a one megawatt power plant. Gujarat has very ambitious plans for use of solar energy for power generation and fortunately there is enough wasteland available in the deserts of northern Gujarat to provide large spaces for solar collectors. Not every State is so fortunately placed. In the Punjab, for example, where there is very little wasteland, one finds it difficult to believe that large solar based power plants can be established. This is emphasised in order to caution our scientists and technologists about the limitations of solar power. Having said that if we disaggregate the use of solar power India provides great scope for it, we have about 300 days of sun shine per year in almost all parts of the country and, therefore, using rooftops for trapping solar energy for domestic purposes has enormous possibilities. We can cut down our lighting, cooling and water heating load on conventional energy systems if we resort to large scale domestic use of solar power. Such application of solar power could also be extended to industry to at least partially meet their energy requirements. India will not become a largely solar power driven economy, but we must fully exploit the potential of solar energy in order to reduce the load on conventional power systems.

One of the areas in which alternative power sources are being sought is wind energy. Again Gujarat is one of the leading States because along large coastal stretches in Saurashtra wind velocity is satisfactory and there are stretches of wasteland available for setting up windmills. Let me contrast this with the city of Bhopal where, despite the fact that it has seven hills, the wind-rose is such that there are at least four months in the year when atmospheric conditions are not favourable for wind energy. For two months wind velocity drops well below optimum levels and wind energy based power generation becomes almost impossible. Therefore, whilst expanding the use of wind energy to the maximum extent possible we should be clear in our minds that the contribution of wind energy power generation, whilst valuable, will still be marginal.

Both DTU and RGTU have vociferously advocated bio-fuels, especially bio diesel synthesised from jatropha seed. Both universities have set up pilot plants and also done some jatropha plantation. The effort is commendable but one has strong reservations on how far it can be taken. Brazil leads in the use of bio-fuels, especially ethanol derived from sugar cane and similar plants which grow easily in tropical Amazonia. In India if we are to become dependent on jatropha based bio-diesel we would have to convert all our cultivated area to jatropha -- a horrendous situation which no one will accept. A better bet would be conversion of water to hydrogen and re-engineering automobile engines to use hydrogen as a hydro-carbon replacement. We have more water than we have jatropha seed, so now we can see where technology should be headed. .

That leaves us with three major sources of power generation, fossil fuel and gas based thermal power generation, nuclear power generation which is again thermal based and hydro power generation which is dependent on water flow. Fossil fuel is a depleting resource and its extraction causes landscape upheavals which are not environment friendly and in its use is highly polluting both on account of emissions and on account of disposal of fly ash. It also necessitates very large scale displacement of people from mining areas. At the same time it is our single biggest source of power generation and, therefore, we cannot abandon it in the near future, greenhouse effect notwithstanding. Here technology must tackle the twin problems of environment friendly mining and efficient combustion which reduces emissions and whose byproduct can be used to produce building materials instead of blighting the landscape. The German State of Rhenish Westphalia pioneered scientific mining in which overburden was removed in a planned manner and, when the mine ran out, was returned to its original location. Top soil was imported and mined areas brought under landscaping and plantation so that they were restored to a near natural landscape in the shortest possible time. India must follow this policy vigorously and honestly. At the same time our technologists must address the problem of dealing with emissions and byproducts so that the carbon footprints of the power plants are kept within such reasonable limits that they do not add to the greenhouse effect.

Another source is nuclear energy. By itself this technology is clean and does not harm the environment directly through emissions or bulky byproducts. A nuclear plant does not produce fly ash. The problem here is how to treat spent fuel which has a substantial half-life and is radio active. The tsunami which hit Japan and caused the disaster at the Fukishima Nuclear Power Plant, Chernobyl and the melt down at the Three Mile Island have created panic about the safety of nuclear plants, especially when a massive natural disaster occurs. Our scientists have repeatedly assured us that, for example, the Kudankulam plant has unprecedented safety factors built into it and the proposed Jaitapur Plant also will be quite safe. One only hopes that corruption, carelessness, lack of supervision in the construction do not undo the safety factors prescribed by the plant design, but one’s trust in the construction industry and government officers is not very high. One wonders whether the design of the plants has taken care of these factors also.

This brings us to the cleanest energy source, hydro power. The water wheel for irrigation, the mill for grinding grain have always been the machines for which water power has been used. The generation of electricity by using water to drive turbines is a relatively recent phenomenon in human history, but water as the driving force has always been there. Water forced through a turbine drives it but creates neither emissions nor heat and as it exits the turbines it can be used for other purposes such as irrigation. The Bhakra Dam, Sardar Sarovar, Indira Sagar are all examples of combined use of water power for electricity generation and for irrigation. With some planning it can further be used for navigation and for transport of goods and people. Our entire Himalayan region has enormous potential for hydro power generation, which would be entirely nonpolluting. Ironically the very source of totally clean power is the one which is opposed by the very environmentalists who consider other sources of power generation to be polluting.

Why should this be so? Our rivers are not really perennial in terms of equitable flow throughout the year. The snow fed Himalayan rivers do have some flow throughout the year, either because it rains or because there is snow-melt. Even here the position is that, for example, at Uttar Kashi and at Tehri the difference between peak season flow and slack season flow of Ganga (Bhagirathi) is 94 percent, with flow at the bottom end of the season being six percent of peak season flow. By contrast the slack season flow of the Narmada at Hoshangabad is about 12 percent to 14 percent of peak season flow. Do we consider the Ganga a perennial river or is the Narmada more perennial, despite the Narmada being totally monsoon based and the Ganga being a snow-fed river? If rivers are not truly equitably perennial then we need to store water, both for irrigation in dry season and for power generation. Run of the river power generation plants have a far smaller possibility of success than is being made out by the environmentalists and it is a pity that our engineers have been unable to come up with a convincing case for building storage reservoirs and not being dependent on run of the river projects.

The minute one mentions storage the environmentalists are up in arms because storage entails submergence, it may bring some forest areas under submergence and certainly it would cause people in the catchment to be displaced. We have still been unable to come up with a truly convincing and effective policy whereby the benefits enjoyed by people in the command of a hydro project are shared equally with the people living in the catchment, with displaced people being rehabilitated in the command area in such a way that they can share in the benefits of the project. We have not been able to evolve a viable policy which can convince even hard bitten environmentalists that forests under submergence will be compensated by alternative forests of as good a quality as the submerged areas. This is an administrative failure and must be corrected. The very environmentalists who oppose a project must be deeply involved in rehabilitation both of people and forests whereby a new partnership develops which facilitates the taking up of hydro projects.

Our entire approach to the power problem is looked at from the supply side. Demand for use of electrical energy on per capita basis is one of the principal indices of the level of development of a country. The power off take per capita in the United States is a multiple of the off take in India and, therefore, the United States is considered more developed than us. No one is suggesting that we should reduce our dependence on electricity because we really cannot go back to an era when oil lamps and candles were the only source of lighting. Therefore, as demand increases we are constantly in search of means of increasing power generation. This has prevented us from looking at the demand side wherein technology is used to reduce the power requirements of every single prime mover in the world so that even with the given power resources we do not suffer shortages. A few examples will illustrate the point.

A tropical country like India uses millions of ceiling fans, not to mention pedestal and table fans. The average ceiling fan needs between 60 and 100 watts of power. Supposing the motor which drives a fan was be made so efficient that it does not require more than 10 watts of power. This would mean a 600 percent improvement in the performance efficiency of the fan. If every fan in India was this many times more efficient than it is today, India would no longer have a power shortage. Extend this to every prime mover, from the smallest motor to the very largest one which drives the machinery of a factory. If the same thinking were applied to the power sector as we do to the IT hardware sector, the world would probably not to have to generate a single extra kilowatt of power for the next fifty years because what we have would suffice for our purpose.

Let me take another example. There are crores of electricity driven pump sets used for lift irrigation. The quality of rural power supply is universally bad in India except, perhaps, in Gujarat. With power being erratically supplied in terms of phases, with regular three phase supply being rare, with there being vast voltage fluctuations, the motors of the pump sets burn out very quickly. The villager electricians do heavy rewinding of the motors and attach a condenser. This permits the motor to run on one phase, two phases and three phases, but very inefficiently and with amperage going up because of the resistance generated by heavy rewinding. There is a great deal of unnecessary loss of power as a result thereof. I have begged our engineering colleges, including Indian Institutes of Technology, to invent a motor whose sensors recognise the quality of power and enable the motor to function under adverse conditions without losing efficiency. Not one of our top engineering institutions has bothered to do any research in this area because this is low end research which would benefit millions of people but would not get the institute much publicity.

The Japanese took the huge radio with its unwieldy valves and by inventing the transistor were able to reduce the radio to the size of a cigarette pack powered by a one and a half volt battery, which enabled one to listen in on the world. From this came the entire integrated circuitry revolution, with the integrated circuit and the silicon micro chip which has completely changed the entire information technology hardware. We need a similar revolution in the design of prime movers so that there is a revolution in the use of power which will take care of the question of the total quantum of power we need and the means of generating such power.

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